REMARKS

Applicant respectfully requests consideration of the subject application. This Response is submitted in response to the Office Action mailed July 24, 2007. Claims 8, 9, 12-16 and 20 are pending. In this Amendment, claim 8 has been amended. No new matter has been added.

35 U.S.C. § 103 Rejections

1. The Examiner has rejected claims 8-9, 12, 14-16 and 20 under 35 U.S.C. § 103(a) as being unpatentable over Dasgupta et al (US 2003/0152835 A1) in view of Gurin (US 2003/0151030A1).

In this regard, applicant makes an amendment clarifying that the binder recited in Claim 8 is selected from the group consisting of sulfur having an average particle size of 1µm or less, metal nanoparticles having an average particle size of 1µm or less and both of them. The amendment is supported by the description at page 12, line 25 to page 13, line 9 and page 19, line 6 to page 20, line 2 of the present specification.

The invention set forth in amended Claim 8 and its dependent claims of Claim 8 cannot be invented from the combination of the cited references as described below:

The invention set forth in Claim 8 (hereinafter "present invention")

relates to a process for preparing a carbon nanotube electrode, comprising the steps of: (1) preparing an electrode material by mixing carbon nanotubes with a binder selected from the group consisting of sulfur having an average particle size of 1μm or less, metal nanoparticles having an average particle size of 1μm or less and both of them, or depositing a binder selected from the group consisting of sulfur having an average particle size of 1μm or less, metal nanoparticles having an average particle size of 1μm or less and both of them on the carbon nanotubes; (2) preparing a pressed electrode material by first pressing the electrode material under a pressure from 1 to 500 atm; and (3) subsequently pressing under a pressure from 1 to 500 atm, or heat-treating at a temperature in the range of the melting point of the sulfur or metal nanoparticles ±200°C in inert gas atmosphere, or simultaneously pressing under the said pressure and heat-treating at the said temperature in inert gas atmosphere the previously pressed electrode material that is placed on a current collector so that the carbon nanotubes are bonded to each other and simultaneously bonded to the current collector.

As described at page 12, lines 6 to 19 of the present specification, in the prior art, organic binders are commonly used in the preparation of carbon nanotubes to fabricate an electrode. However, there is a drawback in preparing carbon nanotubes by using organic binders, such that the internal resistance is increased due to the organic binders in spite of an easy process with such

binders. Also, PF, PVdC and PTFE used as a binder have good affinity to carbon nanotubes, and thus these binders cover most of the surfaces of carbon nanotubes when mixed with carbon nanotubes and processed.

The present invention provides electrodes made of carbon nanotubes characterized in that the binding within the electrode materials comprising carbon nanotubes as well as between the electrode materials and a current collector is achieved by using sulfur, metal or metal compound nanoparticles as a binder and by pressing and/or heating the electrode system, in order to reduce the internal resistance of the electrode, impart strong durability to the electrode, and minimize the contact resistance at the binding interfaces. According to the present invention, it is possible to provide a carbon nanotube electrode having very low Equivalent series resistance (ESR) and high performance (*see* page 12, line 25 to page 13, line 9 of the present specification).

That is, in manufacturing electrodes made of carbon nanotubes, the technical feature of minimizing the internal resistance of the electrode lies in using sulfur or metal nanoparticles as a binder, which has not been used in the prior art. In this regard, the effect of reducing the internal resistance by such technical feature can be confirmed in TEST 1 to TEST 7 of the present specification. The electrodes prepared according to the above TEST 1 to TEST 7 have internal resistance lower than the values of internal resistance reported previously, and this proves that the use of sulfur or metal nanoparticles as a binder is a better process for binding carbon nanotubes to each other as

compared to traditional processes such as binding using organic binders or binding after surface treatments (*see* page 32, lines 1 to 6 of the present specification).

However, the invention set forth in Dasgupta et al. relates to "an anode for a lithium battery having a conductive substrate coated with a pressed compact of spherical graphite and an ion conducting polymeric binder, characterized by comprising the inclusion of up to 1.5 to 15% by weight of carbon nano-fibers in said pressed compact" (*see* Claim 1 of Dasgupta et al.). Like the prior art, Dasgupta et al. only discloses an ion-conducting polymeric binder as a binder used in manufacturing electrodes (*see* [0023] of Dasgupta et al), but does not disclose or suggest the use of sulfur or metal nanoparticles as a binder and the effect of minimizing the internal resistance of the electrode by using thereof.

Meanwhile, the invention set forth in Gurin relates to "an enhanced conductivity nanocomposite, wherein the composite has reduced conductivity path directionality dependence, comprising of (a) a power selected from the group consisting of metals, metal oxides, alloys, and combinations thereof, the powder having an average particle size of from about 1nm to about 100 μm, and (b) a carbon powder wherein the powder having an average particle size of from about 1nm to about 100 μm" (*see* Claim 1 of Gurin). The electrical conductivity nanocomposite described in Gurin is used for conductive inks, circuit boards,

paints etc. (*see* [0006] of Gurin). Although Gurin discloses, "In general, the smaller the particle size for said metal powders the better the conductivity enhancement" (*see* [0058] of Gurin), it only suggests that the use of nano-sized metal powder when manufacturing electrical conductivity nanocomposite used in producing conductive inks, circuit boards, paints etc. results in enhanced conductivity. That is, <u>there is no teaching in Gurin of providing the technical idea of using sulfur or metal nanoparticles as a binder in order to solve the technical problem of increasing the internal resistance of the electrodes when using organic polymers as a binder</u>.

<u>Thus, it is clear that the present invention cannot be invented by a skilled person in the art from the combination of Dasgupta et al. and Gurin</u>.

The examiner states at page 2 of the Office Action regarding Claim 8 of the present application, "Dasgupta et al. disclose a process for preparing a carbon nanotube electrode, comprising the steps of: (1) preparing an electrode material by mixing spherical graphite, which contain about 1.5% to 15% carbon nanotubes, with a binder (paragraph [0023]); (2) preparing a pressed electrode material by first pressing the graphite (carbon nanotube)/binder mixture into a pressed compact with copper foil on one side (paragraph [0023]); and (3) subsequently heat-treating, the heat-treating temperature range being from 40-140°C (paragraph [0015]), the previously pressed electrode material that is placed on a current collector so that the carbon nanotubes are bonded to each other and simultaneously bonded to the current collector (paragraph [0016] and [0023])."

In this regard, steps (1) to (3) of the present invention are different from steps disclosed in Dasgupta et al. as follows:

1) With regard to Step (1)

Dasgupta et al. uses as major electrode material, a spherical graphite containing about 1.5% to 15% carbon nanotubes, and as a binder, ionic conducting polymer. In contrast, the present invention uses carbon nanotube 100% as major electrode material, and sulfur or metal nanoparticles as a binder. Thus, as to the step (1) of the present invention, it is obvious that the starting materials, i.e., electrode materials and binders are different between Dasgupta et al. and the present invention.

2) With regard to Steps (2) & (3)

The examiner states that the process of producing an electrode at paragraph [0023] of Dasgupta et al. is the same as the process of the present invention. However, as seen in examples 1-3 (*see* paragraph [0030]-[0032]) of Dasgupta et al., Dasgupta et al. only discloses that shaping of electrodes is performed by spreading after heat treatment as described at paragraph [0015] and [0016]. The heat treatment described at paragraph [0015] of Dasgupta et al. is to process carbon nanofibers prior to mixing with the meso-phase carbon, and as such, is different from the heat treatment of the present invention performed after mixing the electrode materials and pressing for shaping electrode materials.

Also, as disclosed at paragraph [0014], [0028] and in Claim 6, the heat treatment described at paragraph [0016] of Dasgupta et al. is carried out at 45-80°C for the heat-treating of carbon nanofibers in a paste state, which does not damage organic materials after mixing the electrode materials and a binder or wetting this mixture in an electrolyte. Namely, heat treatment described at paragraph [0015] and [0016] in Dasgupta et al. is not for bonding the binder material but carried out prior to spreading the paste for shaping electrodes.

In contrast, in the present invention, pressing and/or heat treatment is for bonding between the electrode materials after mixing or deposition of sulfur or metal nanoparticles and then shaping the solid electrode materials by first pressing. Thus, as to the step (2) and (3) of the present invention, heat treatment of Dasgupta et al. and heat treatment of the present invention are different in its purpose, temperature range and procedure.

The examiner states at pages 3-4 of the Office Action that since Gurin discloses metal deposited carbon nanotubes, the present invention can be anticipated from the combination of Dasgupta et al. and Gurin.

Although Gurin discloses a metal particle of Au, Ag, Pd, Pt, Cu, Ni, Fe, Co, Be, Mo, Si, Tn, Sn, Al and In, it merely suggests coating metal particles on the surface of carbon nanotubes, but does not suggest forming bonds between carbon nanotubes and sulfur or metal nanoparticles which is used as a binder of the electrode materials.

In this regard, the examiner has rejected Claim 8 based on the

combination of Dasgupta et al. and Gurin. However, Dasgupta et al. and Gurin do not suggest the role of sulfur or metal nanoparticles as a binder at all, and it is not possible to achieve the effect of the present invention as a binder by the metal nanoparticles merely being deposited on the surface of carbon nanotubes as in Gurin.

The examiner cites *In re Boesch,* CCPA 1980, 617 F.2d 272, 205 USPQ 215, in the Office Action mailed July 24, 2007. The Examiner relies upon this case law to show the optimization of ranges of a result-effective variable being routine experimentation.

However, *In re Boesch,* contained prior art that suggested proportional balancing to achieve desired results in the formation of an alloy.

In contrast, none of the prior art relied upon for rejection (Dasgupta et al., Gurin, and Choi et al.) suggests proportional balancing of pressure during the pressing of an electrode material. Claim 8 requires the pressing to occur under a pressure from 1 to 500 atm which is not shown in the prior art. Therefore, *In re Boesch* is distinguished upon the facts and does not apply.

In light of the above, the process disclosed in Dasgupta et al. is different from the step (1) to step (3) of Claim 8 of the present application, and Gurin and Choi et al. neither suggest or disclose the use of sulfur or metal nanoparticles for binding carbon nanotubes for manufacturing electrodes made of carbon nanotubes.

Thus, it is clear that a skilled person cannot derive the present invention

from the combination of Dasgupta et al., Gurin and Choi et al. Also, it is clear that Claims 9, 12 to 16, 20 which depend from Claim 8 cannot be derived from the combination of Dasgupta et al., Gurin and Choi et al.

With respect to claim 9, the examiner relies upon *In re Robertson*, 49 USPQ 2d 1949 (1999), to show an alleged inherent characteristic of uniformly dispersing an electrode material. However, *In re Robertson* itself held that inherency may not be established by probabilities or possibilities and that the mere fact that a certain thing may result from a given set of circumstances is not sufficient. *see In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999).

None of the prior art teaches the electrode material being pressed under a pressure from 1 to 500 atm. Therefore, it is undisclosed in the prior art as to whether the electrode material is uniformly dispersed in Dasgupta et al. and Gurin, and thus this feature is <u>not</u> inherent in the prior art.

Applicant, accordingly, respectfully requests withdrawal of the rejections of claims 8-9, 12, 14-16 and 20 under 35 U.S.C. § 103(a) as being unpatentable over Dasgupta et al (US 2003/0152835 A1) in view of Gurin (US 2003/0151030A1).

2. The Examiner has rejected claim 13 under 35 U.S.C. § 103(a) as being unpatentable over Dasgupta et al (US 2003/0152835 A1) and Gurin (US 2003/0151030A1), as applied to claims 8-9, 12, 14-16 and 20 above, and in further view of Choi et al, (US 2004/0018416A1).

Choi et al. relates to depositing metal particles which are the CNT synthesis catalyst on a carbon substrate to synthesize CNTs by the chemical vapor deposition (CVD) reaction, and using the metallic catalyst particles distributed on the internal and external surface of the CNTs (*see* paragraph [0003], [0016] and [0020] of Choi et al.). That is, Choi et al. merely discloses metal particles as a catalyst used when generating carbon nanotubes, but does not disclose or suggest the use of metal particle as a binder for binding carbon nanotubes.

Thus, even a skilled person in the art cannot derive using sulfur or metal nanoparticles as a binder instead of an organic binder for preparing an electrode material from Choi et al. Therefore, it is clear that the present invention cannot be achieved by a skilled person in the art from the combination of Dasgupta et al, Gurin and Choi et al.

Applicant, accordingly, respectfully requests withdrawal of the rejections of claim 13 under 35 U.S.C. § 103(a) as being unpatentable over Dasgupta et al (US 2003/0152835 A1) and Gurin (US 2003/0151030A1), as applied to claims 8-9, 12, 14-16 and 20 above, and in further view of Choi et al, (US 2004/0018416A1).

Applicant respectfully submits that the present application is in condition for allowance. If the Examiner believes a telephone conference would expedite or assist in the allowance of the present application, the Examiner is invited to call Louis Tran at (408) 720-8300.

Please charge any shortages and credit any overages to Deposit Account No. 02-2666. Any necessary extension of time for response not already requested is hereby requested. Please charge any corresponding fee to Deposit Account No. 02-2666.

Respectfully submitted,

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